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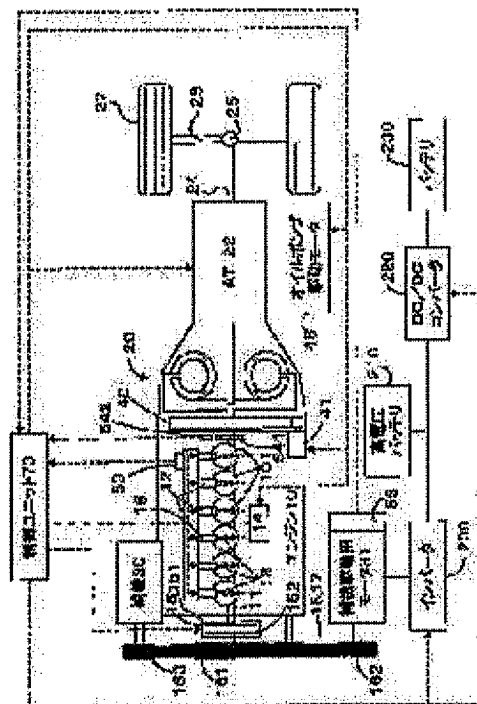
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## (54) START CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE AND VEHICLE HAVING IT

(57)Abstract:

PROBLEM TO BE SOLVED: To improve exhaust gas properties in starting of an internal combustion engine as well as to improve startability of the internal combustion engine.

SOLUTION: In starting of an engine 10, a control unit 70 determines a cylinder 101 for injecting fuel on the basis of a cylinder judged result based on fuel pressure detected by a fuel pressure sensor 50, a crank angle signal position from a crank position sensor 54, and a cylinder discriminating signal from a cam position sensor 52. The control unit 70 injects high-pressure fuel to the determined cylinder 101 through an injector 12. When fuel injection is performed in the latter period of a



compression stroke of the cylinder 101, the engine 10 can be started in first ignition timing.

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## CLAIMS

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[Claim(s)]

[Claim 1] It is a fuel injection control device at the time of start up of an internal-combustion engine provided with a fuel injection valve which carries out direct injection of the fuel by which pressure up was carried out with the pressure-up device characterized by comprising the following which makes an internal-combustion engine the source of power into a cylinder. A fuel-pressure detection means to detect a pressure of fuel which can be injected by said fuel injection valve at the time of start up.

A fuel-injection-timing determination means to determine a stage of fuel injection in a combustion cycle according to a pressure of said detected fuel.

An injection control means which injects fuel via said fuel injection valve at said determined fuel injection timing.

[Claim 2] In a fuel injection control device, said internal-combustion engine has two or more cylinders at the time of start up of the internal-combustion engine according to claim 1, It is a fuel injection control device at the time of start up of an internal-combustion engine which said fuel injection valve is arranged at each cylinder, respectively, and is characterized by having a cylinder discrimination means to distinguish a cylinder in fuel injection timing further determined by said fuel-injection-timing determination means out of said two or more cylinders.

[Claim 3] It is a fuel injection control device at the time of start up of an internal-combustion engine characterized by said fuel-injection-timing determination means determining a compression stroke as fuel injection timing when a pressure of said fuel is more than the 1st pressure in a fuel injection control device at the time of start up of the internal-combustion engine according to claim 1 or 2.

[Claim 4] It is a fuel injection control device at the time of start up of an internal-combustion

engine characterized by said fuel-injection-timing determination means determining an intake stroke as fuel injection timing when a pressure of said fuel is less than said 1st pressure in a fuel injection control device at the time of start up of the internal-combustion engine according to claim 3.

[Claim 5] Said fuel-injection-timing determination means is a fuel injection control device at the time of start up of an internal-combustion engine determining the second half of a compression stroke at fuel injection timing in more than the 2nd pressure in a fuel injection control device whose pressure of said fuel is higher than said 1st pressure at the time of start up of the internal-combustion engine according to claim 3.

[Claim 6] It is a fuel injection control device at the time of start up of an internal-combustion engine with which said fuel-injection-timing determination means is characterized by a pressure of said fuel being less than said 2nd pressure, and determining the first half of a compression stroke at fuel injection timing in more than said 1st pressure in a fuel injection control device at the time of start up of the internal-combustion engine according to claim 5.

[Claim 7] It is a fuel injection control device at the time of start up of an internal-combustion engine which is provided with the following and characterized by said injection control means starting fuel injection to said distinguished cylinder after said detected cylinder internal pressure becomes below in a predetermined value, when judged with said start demand not being a thing based on a vehicle departing demand.

A cylinder-internal-pressure detection means by which a fuel injection control device detects a pressure in said cylinder further at the time of start up of the internal-combustion engine according to claim 1.

A start demand judging means which judges whether a start demand of said internal-combustion engine is a thing based on a vehicle departing demand which requires start of vehicles.

[Claim 8] A start control device of an internal-combustion engine with which a fuel injection equipment which carries out direct injection of the fuel by which it had two or more cylinders characterized by comprising the following, and pressure up was carried out to each cylinder with the pressure-up device which makes an internal-combustion engine the source of power into a cylinder is arranged.

A fuel-pressure detection means to detect a pressure of fuel injected by said fuel injection equipment.

A cylinder discrimination means to distinguish a compression-stroke cylinder which is in a compression stroke among said two or more cylinders.

A first time injection cylinder determination means to determine a first time injection cylinder which injects fuel first at the time of start up of said internal-combustion engine based on a

discriminated result by said cylinder discrimination means, and said detected pressure of fuel. A start means which fuel is injected via said fuel injection equipment to said determined first time injection cylinder, and performs ignition and starts said internal-combustion engine.

[Claim 9]A start control device when a pressure of said detected fuel is more than the 1st pressure in a start control device of the internal-combustion engine according to claim 8, wherein said first time injection cylinder determination means determines said compression-stroke cylinder distinguished by said cylinder discrimination means as a first time injection cylinder.

[Claim 10]In a start control device of the internal-combustion engine according to claim 8, a pressure of said detected fuel is less than said 1st pressure, and in more than the 2nd pressure lower than the 1st pressure, A start control device of an internal-combustion engine determining the next compression-stroke cylinder which invites a compression stroke to the next of said compression-stroke cylinder as a first time injection cylinder.

[Claim 11]A start control device of an internal-combustion engine characterized by a thing which invite a compression stroke to the next of said next compression-stroke cylinder, and for which one term compression-stroke cylinder after another is determined as a first time injection cylinder when a pressure of said detected fuel is less than said 2nd pressure in a start control device of the internal-combustion engine according to claim 10.

[Claim 12]Have the following, and when it judges that said start demand is not a thing based on a vehicle departing demand, said start means, A start control device of an internal-combustion engine characterized by performing injection and ignition to fuel to said determined first time injection cylinder after said detected cylinder internal pressure becomes below in a predetermined value.

A cylinder-internal-pressure detection means by which a start control device of the internal-combustion engine according to claim 9 detects a pressure in said cylinder further.

A start demand judging means which judges whether a start demand of said internal-combustion engine is a thing based on a vehicle departing demand which requires start of vehicles.

[Claim 13]A start control device of an internal-combustion engine with which a fuel injection equipment which carries out direct injection of the fuel by which it had two or more cylinders characterized by comprising the following, and pressure up was carried out to each cylinder with the pressure-up device which makes an internal-combustion engine the source of power into a cylinder is arranged.

A fuel-pressure detection means to detect a pressure of fuel injected by said fuel injection equipment.

A cylinder group identification device which identifies a specific cylinder group which is in a compression stroke or initial distance of an exhaust stroke among said two or more cylinders. A cylinder discrimination means to distinguish a compression-stroke cylinder which is in a compression stroke among said specific cylinder groups after said specific cylinder group is identified.

A first time injection cylinder determination means to determine a first time injection cylinder which injects fuel first at the time of start up of said internal-combustion engine based on a discriminated result by said cylinder group identification device, a discriminated result by said cylinder discrimination means, and said detected pressure of fuel, A start means which fuel is injected via said fuel injection equipment to said determined first time injection cylinder, and performs ignition and starts said internal-combustion engine.

[Claim 14]In a start control device of the internal-combustion engine according to claim 13, said first time injection cylinder determination means, Although said specific cylinder group is identified, said compression-stroke cylinder is not judged, but when a pressure of said detected fuel is more than the 1st pressure, A start control device determining said compression-stroke cylinder as a first time injection cylinder when distinction of said compression-stroke cylinder of a cylinder by said cylinder discrimination means is stood by and said compression-stroke cylinder is distinguished.

[Claim 15]A start control device of an internal-combustion engine which a pressure of said detected fuel is less than said 1st pressure in a start control device of the internal-combustion engine according to claim 14, and is characterized by determining said identified specific cylinder group as a first time injection cylinder in more than the 2nd pressure lower than the 1st pressure.

[Claim 16]A start control device of an internal-combustion engine characterized by determining a cylinder group which invites a compression stroke or an exhaust stroke to the next of said specific cylinder group as a first time injection cylinder when a pressure of said detected fuel is less than said 2nd pressure in a start control device of the internal-combustion engine according to claim 15.

[Claim 17]Vehicles which equip a claim of either claim 8 thru/or claim 16 with a start control device of an internal-combustion engine of a statement.

[Claim 18]The vehicles according to claim 17 suspend idling operation of the state \*\*\*\*\* aforementioned internal-combustion engine of vehicles further, Vehicles, wherein it has an idling control means to resume operation of said internal-combustion engine which suspended idling operation and resumption of operation of said internal-combustion engine is controlled by said start control device when resuming operation of said internal-combustion engine.

[Claim 19]Vehicles which equip a claim of either claim 1 thru/or claim 7 with a fuel injection

control device of a statement.

[Claim 20]The vehicles according to claim 19 suspend idling operation of the state \*\*\*\*\*  
aforementioned internal-combustion engine of vehicles further, Vehicles, wherein it has an  
idling control means to resume operation of said internal-combustion engine which suspended  
idling operation and supply of fuel to said internal-combustion engine is controlled by said fuel  
injection control device when resuming operation of said internal-combustion engine.

[Claim 21]It has two or more cylinders, and is a start control method in an internal-combustion  
engine with which a fuel injection equipment which carries out direct injection of the fuel by  
which pressure up was carried out to each cylinder with the pressure-up device which makes  
an internal-combustion engine the source of power into a cylinder is arranged, Detect a  
pressure of fuel which can be injected with said fuel injection equipment, and a cylinder group  
recognition signal which shows that a specific cylinder group is in a compression stroke or  
initial distance of an exhaust stroke among said two or more cylinders is detected, Detect a  
cylinder discrimination signal for distinguishing a compression-stroke cylinder which is in a  
compression stroke among said specific cylinder groups, and Said cylinder group recognition  
signal, Based on a cylinder discrimination signal detected after detecting said cylinder group  
recognition signal, and said detected pressure of fuel, A first time injection cylinder which  
injects fuel first at the time of start up of said internal-combustion engine is determined, Before  
said first time injection cylinder sees ignition timing, an ignition cylinder is determined based on  
a cylinder discrimination signal detected after detecting said cylinder group recognition signal  
and a cylinder group recognition signal, A start control method of an internal-combustion  
engine which fuel is injected via said fuel injection equipment to said determined first time  
injection cylinder, and performs ignition to said ignition cylinder and starts said internal-  
combustion engine.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] Especially this invention relates to the suitable start control art for the direct injection type internal-combustion engine with which direct injection of the fuel is carried out into a cylinder about the art of the start control of an internal-combustion engine.

[0002]

[Description of the Prior Art] In order to control the combustion state of an internal-combustion engine more correctly according to the operational status of vehicles, the direct injection type internal-combustion engine which injects fuel directly in a cylinder is put in practical use. In the direct injection type internal-combustion engine, the fuel consumption of an internal-combustion engine is generally raised by performing stratification combustion in the low loading field of an internal-combustion engine. This stratification combustion is realized by performing fuel injection in a compression stroke.

If it hits injecting fuel, it is required that fuel should be injected with high fuel pressure (fuel pressure) so that the rise of the cylinder internal pressure in a compression stroke may be overcome.

However, this high fuel pressure is generally generated by the mechanical pump (high pressure pumping) driven with the internal-combustion engine under operation.

When operation of an internal-combustion engine is suspended, the fuel pressure generated with the passage of time may fall.

[0003] Then, also in such a direct injection type internal-combustion engine, the problem that the fuel pressure at the time of start up of an internal-combustion engine is insufficient similarly [ the conventional internal-combustion engine ] by injecting the low fuel of fuel pressure in a cylinder by an intake stroke is avoided at the time of start up (JP,8-312401,A). Or after

injecting fuel repeatedly and making fuel fully atomize in a cylinder, the problem at the time of start up of an internal-combustion engine that fuel pressure is insufficient is avoided by performing ignition treatment (JP,11-270387,A).

[0004]

[Problem(s) to be Solved by the Invention]However, since deer execution of it was not carried out after ignition passes through a compression stroke when injecting fuel by an intake stroke at the time of start up of an internal-combustion engine, adopting a direct injection type internal-combustion engine, quick start up of the internal-combustion engine was not able to be expected. On the other hand, if it is going to inject fuel in the cylinder (cylinder in the second half of a compression stroke) which sees ignition timing immediately after a cranking start, fuel pressure may be insufficient and it will not necessarily become bringing start up forward. In vehicles provided with the idling stop function to make the idling operation of an internal-combustion engine suspend and resume especially according to a vehicle state, the delay in start up of an internal-combustion engine will bar a re-run of smooth vehicles.

[0005]This invention is made in order to solve the above-mentioned problem, and an object of this invention is to raise the startability of an internal-combustion engine. It aims at raising the exhaust gas characteristic at the time of internal-combustion engine start up.

[0006]

[The means for solving a technical problem, and its operation and effect] In order to solve the above-mentioned technical problem, the 1st mode of this invention provides a fuel injection control device at the time of start up of an internal-combustion engine provided with the fuel injection valve which carries out direct injection of the fuel by which pressure up was carried out with the pressure-up device which makes an internal-combustion engine the source of power into a cylinder. A fuel-pressure detection means to be the fuel injection concerning the 1st mode of this invention, and to detect the pressure of the fuel which can be injected by said fuel injection valve at the time of start up, It has a fuel-injection-timing determination means to determine the stage of the fuel injection in a combustion cycle according to the pressure of said detected fuel, and an injection control means which injects fuel via said fuel injection valve at said determined fuel injection timing.

[0007]At the time of start up concerning the 1st mode of this invention, a fuel injection control device, Since the stage of the fuel injection in a combustion cycle is determined according to the pressure of the detected fuel and fuel is injected via a fuel injection valve at the determined fuel injection timing, even if it is at the start-up time of an internal-combustion engine, according to fuel pressure, fuel injection can be performed at the suitable stage of a combustion cycle.

[0008]In [ time of start up of an internal-combustion engine concerning the 1st mode of this invention ] a fuel injection control device, Said internal-combustion engine has two or more

cylinders, said fuel injection valve is arranged at each cylinder, respectively, and said fuel injection control device can be provided with a cylinder discrimination means to distinguish a cylinder which is in fuel injection timing determined by said fuel-injection-timing determination means further out of said two or more cylinders. Said fuel-injection-timing determination means can determine a compression stroke as fuel injection timing, when a pressure of said fuel is more than the 1st pressure. Said fuel-injection-timing determination means can determine an intake stroke as fuel injection timing, when a pressure of said fuel is less than said 1st pressure.

[0009]When fuel pressure is the 1st more than pressure, for example, 5 MPa, by having such composition, it can become possible to perform fuel injection at the first ignition timing, and the startability of an internal-combustion engine can be raised. When fuel pressure is less than the 1st pressure, it becomes possible to perform fuel injection at the next ignition timing, and start timing of an internal-combustion engine can be brought forward, supplying fuel in a cylinder certainly in an intake stroke. Since fuel is injected to a cylinder in a compression stroke or an intake stroke, unburnt glow gas cannot be discharged, and an exhaust gas characteristic can be raised.

[0010]In a fuel injection control device, in more than the 2nd pressure whose pressure of said fuel is higher than said 1st pressure, although said fuel-injection-timing determination means determines the second half of a compression stroke as fuel injection timing, it can be done at the time of start up concerning the 1st mode of this invention. A pressure of said fuel is less than said 2nd pressure, and, in more than said 1st pressure, said fuel-injection-timing determination means can determine the first half of a compression stroke at fuel injection timing.

[0011]When fuel pressure is the 2nd more than pressure, for example, 10 MPa, by having such composition, it becomes possible to perform fuel injection in the second half of the compression stroke which sees ignition timing soon, and an internal-combustion engine can be promptly put into operation more. Since fuel injection can be performed in early stages of the compression stroke near [ intake stroke ] ignition timing also when fuel pressure is less than the 2nd pressure, the startability of an internal-combustion engine can be raised.

[0012]A cylinder-internal-pressure detection means by which a fuel injection control device detects a pressure in said cylinder further at the time of start up concerning the 1st mode of this invention, A start demand of said internal-combustion engine is provided with a start demand judging means which judges whether it is a thing based on a vehicle departing demand which requires start of vehicles, and it said injection control means, After said detected cylinder internal pressure becomes below in a predetermined value, it may be made to start fuel injection to said distinguished cylinder, when it judges that said start demand is not a thing based on a vehicle departing demand.

[0013] Since the first fuel injection and explosive combustion can be performed in a place where an air content inhaled in a cylinder decreased when it has such composition, it becomes possible to reduce a firing pressure and vibration accompanying start up of an internal-combustion engine by the vehicles side demand, etc. can be controlled.

[0014] The 2nd mode of this invention has two or more cylinders, and it provides a start control device of an internal-combustion engine with which a fuel injection equipment which carries out direct injection of the fuel by which pressure up was carried out to each cylinder with the pressure-up device which makes an internal-combustion engine the source of power into a cylinder is arranged. This invention is characterized by a start control device concerning the 2nd mode comprising the following.

A fuel-pressure detection means to detect a pressure of fuel injected by said fuel injection equipment.

A cylinder discrimination means to distinguish a compression-stroke cylinder which is in a compression stroke among said two or more cylinders.

A first time injection cylinder determination means to determine a first time injection cylinder which injects fuel first at the time of start up of said internal-combustion engine based on a discriminated result by said cylinder discrimination means, and said detected pressure of fuel.

A start means which fuel is injected via said fuel injection equipment to said determined first time injection cylinder, and performs ignition and starts said internal-combustion engine.

[0015] A discriminated result [ according to the start control device concerning the 2nd mode of this invention ] by a cylinder discrimination means, And based on a pressure of detected fuel, determine a first time injection cylinder which injects fuel first at the time of start up of an internal-combustion engine, and fuel is injected via a fuel injection equipment to a determined first time injection cylinder, and ignition can be performed. Therefore, also in the time of start up of an internal-combustion engine, fuel injection is carried out in a compression stroke, it becomes possible to perform explosive combustion by ignition, and start timing of an internal-combustion engine can be brought forward. Each distance in a combustion cycle of an internal-combustion engine is associated respectively, for example, distinguishes a compression-stroke cylinder directly in distinction of a compression-stroke cylinder, and also it is possible by distinguishing an intake-stroke cylinder.

[0016] In a start control device concerning the 2nd mode of this invention, said first time injection cylinder determination means can determine said compression-stroke cylinder distinguished by said cylinder discrimination means as a first time injection cylinder, when a pressure of said detected fuel is more than the 1st pressure. A pressure of said detected fuel is less than said 1st pressure, and, in more than the 2nd pressure lower than the 1st pressure, the next compression-stroke cylinder which invites a compression stroke to the next of said

compression-stroke cylinder can be determined at a first time injection cylinder. When a pressure of said detected fuel is less than said 2nd pressure, the following next compression-stroke cylinder which invites a compression stroke to the next of said next compression-stroke cylinder can be determined as a first time injection cylinder.

[0017]By having such composition, it becomes possible to perform fuel injection to a cylinder which sees ignition timing early according to fuel pressure, and start timing of an internal-combustion engine can be brought forward. The 1st pressure in the 2nd mode is 5MPa, for example, and the 2nd pressure is 10MPa.

[0018]Also in a start control device concerning the 2nd mode of this invention, in order to reduce vibration at the time of start up of an internal-combustion engine, a stage of fuel injection to a first time injection cylinder may be delayed like a fuel injection control device at the time of start up concerning the 1st mode until a pressure in a cylinder becomes below in a predetermined value.

[0019]The 3rd mode of this invention has two or more cylinders, and it provides a start control device of an internal-combustion engine with which a fuel injection equipment which carries out direct injection of the fuel by which pressure up was carried out to each cylinder with the pressure-up device which makes an internal-combustion engine the source of power into a cylinder is arranged. This invention is characterized by a start control device concerning the 3rd mode comprising the following.

A fuel-pressure detection means to detect a pressure of fuel injected by said fuel injection equipment.

A cylinder group identification device which identifies a specific cylinder group which is in a compression stroke or initial distance of an exhaust stroke among said two or more cylinders.

A cylinder discrimination means to distinguish a compression-stroke cylinder which is in a compression stroke among said specific cylinder groups after said specific cylinder group is identified.

A first time injection cylinder determination means to determine a first time injection cylinder which injects fuel first at the time of start up of said internal-combustion engine based on a discriminated result by said cylinder group identification device, a discriminated result by said cylinder discrimination means, and said detected pressure of fuel, A start means which fuel is injected via said fuel injection equipment to said determined first time injection cylinder, and performs ignition and starts said internal-combustion engine.

[0020]Since a specific cylinder group which is in a compression stroke or initial distance of an exhaust stroke among two or more cylinders is discriminable according to the start control device concerning the 3rd mode of this invention, even if cylinder discrimination is before completion, fuel can be preparatorily injected to a cylinder which greets a compression stroke

at the time of cylinder discrimination. It can become possible, even if it is when injection of fuel is impossible at the time of cylinder discrimination from the side of fuel pressure to supply fuel in a cylinder in accordance with the first ignition timing by this, and the startability of an internal-combustion engine can be raised.

[0021]In a start control device concerning the 3rd mode of this invention, said first time injection cylinder determination means, Although said specific cylinder group is identified, said compression-stroke cylinder is not judged, but when a pressure of said detected fuel is more than the 1st pressure, Distinction of said compression-stroke cylinder of a cylinder by said cylinder discrimination means is stood by, and when said compression-stroke cylinder is distinguished, said compression-stroke cylinder can be determined as a first time injection cylinder. A pressure of said detected fuel is less than said 1st pressure, and, in more than the 2nd pressure lower than the 1st pressure, said identified specific cylinder group can be determined at a first time injection cylinder. When a pressure of said detected fuel is less than said 2nd pressure, a cylinder group which invites a compression stroke or an exhaust stroke to the next of said specific cylinder group can be determined as a first time injection cylinder.

[0022]When fuel pressure is the 1st more than pressure, for example, 10 MPa, by having such composition, it can wait for cylinder discrimination completion, fuel injection in a compression stroke can be performed, and it can light at the first ignition timing. Fuel pressure is less than the 1st pressure, and to the 2nd pressure, for example, a case of 5 or more MPa. It becomes possible from the side of fuel pressure to supply fuel in a cylinder at a stage in which fuel supply is possible to a cylinder which is in a compression stroke first after cylinder discrimination, i.e., a cylinder which invites ignition timing to the beginning, and start timing of an internal-combustion engine can be brought forward. When fuel pressure is less than the 2nd pressure, a cylinder which greets the 2nd compression stroke after cylinder discrimination, i.e., a cylinder which sees the 2nd ignition timing, is received, It becomes possible from the side of fuel pressure to supply fuel in a cylinder at a stage in which fuel supply is possible, and the earliest possible stage can be made to put an internal-combustion engine into operation.

[0023]The 4th mode of this invention provides vehicles provided with a fuel injection control device concerning the 1st mode of this invention. The 5th mode of this invention provides vehicles provided with a start control device concerning the 2nd or 3rd mode of this invention. In having this composition, quick vehicle departing becomes possible.

[0024]Vehicles concerning the 4th and 5th modes of this invention suspend idling operation of the state \*\*\*\*\* aforementioned internal-combustion engine of vehicles further, It has an idling control means to resume operation of said internal-combustion engine which suspended idling operation, and supply of fuel to said internal-combustion engine may be made to be controlled by said fuel injection control device or said start control device when resuming operation of said internal-combustion engine. By having such composition, re-start of quick vehicles after

an idling operation stop is attained.

[0025]The 6th mode of this invention has two or more cylinders, and it provides a start control method in an internal-combustion engine with which a fuel injection equipment which carries out direct injection of the fuel by which pressure up was carried out to each cylinder with the pressure-up device which makes an internal-combustion engine the source of power into a cylinder is arranged. A method concerning the 6th mode of this invention detects a pressure of fuel which can be injected with said fuel injection equipment, A cylinder group recognition signal which shows that a specific cylinder group is in a compression stroke or initial distance of an exhaust stroke among said two or more cylinders is detected, Detect a cylinder discrimination signal for distinguishing a compression-stroke cylinder which is in a compression stroke among said specific cylinder groups, and Said cylinder group recognition signal, Based on a cylinder discrimination signal detected after detecting said cylinder group recognition signal, and said detected pressure of fuel, A first time injection cylinder which injects fuel first at the time of start up of said internal-combustion engine is determined, Before said first time injection cylinder sees ignition timing, an ignition cylinder is determined based on a cylinder discrimination signal detected after detecting said cylinder group recognition signal and a cylinder group recognition signal, Fuel is injected via said fuel injection equipment to said determined first time injection cylinder, and ignition is performed to said ignition cylinder, said internal-combustion engine is started, and it is characterized by things.

[0026]Since a specific cylinder group which is in a compression stroke or initial distance of an exhaust stroke among two or more cylinders is discriminable according to a method concerning the 6th mode of this invention, even if cylinder discrimination is before completion, fuel can be preparatorily injected to a cylinder which greets a compression stroke at the time of cylinder discrimination. This becomes possible, even if it is when injection of fuel is impossible at the time of cylinder discrimination from the side of fuel pressure to supply fuel in a cylinder in accordance with the first ignition timing, and start timing of an internal-combustion engine can be brought forward.

[0027]This invention can be specified as a method respectively similarly about the 1st and 2nd modes of this invention, and an operation and an effect equivalent to the 1st and 2nd modes of this invention can be done so, respectively.

[0028]

[Embodiment of the Invention]It explains based on an example, referring to drawings for the start control device of the internal-combustion engine concerning this invention hereafter.

[0029]The outline composition of the vehicles with which the idling stop control device containing the start control device applied to this example with reference to drawing 1 and drawing 2 may be used is explained. Drawing 1 is a block diagram showing the outline composition of the vehicles with which the 1st example is applied. Drawing 2 is an explanatory

view showing the outline composition of the circumference of an engine.

[0030] Vehicles are automatically provided with the automatic owner stage gearbox (AT) 22 which can be changed into an owner stage for the moderating ratio between the torque converter 20 and maximum deceleration ratio which amplify the output torque of the engine (internal-combustion engine) 10 as the source of power, and the engine 10, and the minimum moderating ratio. The engine 10 is combined with the power input shaft of the torque converter 20 via the crankshaft (output shaft) 11, the power output axis of the torque converter 20 is combined with the power input shaft of AT22, and the power output axis of AT22 is combined with the drive shaft 24. The drive shaft 24 is combined with the wheel 27 via the differential gear (a final gear is included) 25 and the axle 26.

[0031] The engine 10 is a direct fuel-injection gasoline engine of the form that direct injection of the fuel (for example, gasoline fuel) is carried out into the cylinder 101, as shown in drawing 2. The cylinder head 102 of the engine 10 is provided with the spark plug 13 for lighting gasoline fuel at the gaseous mixture formed of the high voltage type injector 12 for injecting in the cylinder 101, the gasoline injected in the cylinder 101, and the inhaled air. The gasoline fuel of the high pressure force by which pressure up was carried out to the high voltage type injector 12 with the high pressure fuel pump 19 driven with the engine 10 is supplied via the delivery pipe 18. If the high voltage type injector 12 opens based on the injection signal from the control unit 70, gasoline fuel will be sprayed in the cylinder 101. The delivery pipe 18 is equipped with the fuel pressure sensor 50 which detects the fuel pressure  $P_f$  which can be injected, the pressure (fuel pressure) 12, i.e., the high voltage type injector, of fuel in a delivery pipe. Based on the ignition signal from the control unit 70, high tension is supplied to the spark plug 13 from the igniter 14. An ignition signal is transmitted to the igniter 14 from the control unit 70, after cylinder discrimination is completed.

[0032] The cylinder head 102 of the engine 10, Suction air. The inlet port 103 and combustion gas which are introduced in the cylinder 101. It has the suction valve 110 which opens for free passage or intercepts the exhaust port 104 and the inlet port 103 which are discharged out of the cylinder 101, and the cylinder 101, and the exhaust valve 111 which opens for free passage or intercepts the exhaust port 104 and the cylinder 101. The inlet pipe 120 for introducing exterior air is combined with the inlet port 103. The inlet pipe 120 is equipped with the surge tank 121 which has the intake pressure sensor 51, and the throttle valve 122 which adjusts the suction air quantity into the cylinder 101. The opening-and-closing drive of the suction valve 110 and the exhaust valve 111 is carried out to predetermined timing by the cam 113 with which the cam shaft 112 is equipped. The suction valve 110 is equipped with the variable valve timing mechanism which changes valve opening and closing timing into a continuation variable target from the maximum angle-of-delay position to the maximum tooth-lead-angle position. Near the cam shaft 112, the cam position sensor 52 which outputs the

cylinder discrimination signal for cylinder discrimination is arranged.

[0033]The cylinder block 105 of the engine 10 is equipped with the coolant temperature sensor 53 for detecting the coolant temperature which cools the engine 10. The crankshaft 11 is equipped with the crank position sensor 54 which detects the crank position of the crankshaft 11, and crank angle speed. The crank position sensor 54 is provided with the following. The crankshaft timing pulley 541 in which the signal gear tooth which contains the toothless part for detecting a top dead center (TDC) in a peripheral part is formed. The electromagnetism pickup 542 of the MPU type which detects passage of a signal gear tooth and outputs a crank rotation signal to every 30-degreeCA (the degree of crank angle).

[0034]Around the engine 10, the auxiliary machinery 30, such as a water pump, an air conditioning compressor, and a pump for power steering, and the motor 31 for an auxiliary machinery drive for driving the auxiliary machinery 30 at the time of the engine shutdown by idling stop processing (electric motor) are arranged. The power input shaft of each auxiliary machinery 30 and the end of the crankshaft 11 of the engine 10 are equipped with the belt pulleys 160 and 161, respectively. The transmission belt 16 for starting the engine 10 by the motor 31 for an auxiliary machinery drive is installed by the belt pulley 161 of the engine 10, and the belt pulley 162 of the motor 31 for an auxiliary machinery drive. The pulley ratio of the belt pulley 161 and the belt pulley 162 is generally 1:2 to about 1:3. The transmission belt 17 is installed by each belt pulley 160, 161, and the output of the engine 10 is transmitted to the power input shaft of the auxiliary machinery 30 via this transmission belt 17, and the output of the motor 31 for an auxiliary machinery drive is transmitted to the power input shaft of the auxiliary machinery 30 via the transmission belt 16 and the transmission belt 17. What is called a V belt whose sectional shape is a trapezoid as the transmission belts 16 and 17, Or thickness is more thinly [ than a V belt ] broad, and what is called a V rib belt etc. with which two or more V character-like slots are formed along the hand of cut are used, and the material from which absorption features, such as a shock and vibration, change depending on temperature is used.

[0035]Between the crankshaft 11 and the belt pulley 161, the electromagnetic clutch 15 of the wet multi-board type is infixed. The electromagnetic clutch 15 may be provided with the clutch plate 151 and the flywheel 152, as shown in drawing 1, it may have it apart from the belt pulley 161, and it may be built in the belt pulley 161. Cutting and connection of transmitting power between the crankshaft 11 and the transmission belt 16 are realized by this electromagnetic clutch 15. The damper which is not illustrated in order to aim at mitigation of the shock produced at the time of connection and vibration is built in the electromagnetic clutch 15.

[0036]At the time of vehicle running or the vehicle interdiction in the state where the engine 10 is operating, since it is connected and the driving force of the crankshaft 11 is transmitted to

the transmission belt 17, the electromagnetic clutch 15 drives the auxiliary machinery 30 with the engine 10. On the other hand, at the time of the shutdown of the engine 10 by idling stop processing, it is released, the crankshaft 11 and the belt pulley 161 are divided mechanically, and the electromagnetic clutch 15 drives the auxiliary machinery 30 by the motor 31 for an auxiliary machinery drive via the transmission belt 16 and the belt pulley 161. At this time, since the crankshaft 11 is divided mechanically [ the belt pulley 161 and the transmission belts 16 and 17 ], the motor 31 for an auxiliary machinery drive does not need to drive the crankshaft 11, and the load concerning the motor 31 for an auxiliary machinery drive is reduced.

[0037]The motor 31 for an auxiliary machinery drive functions as a driving force source which is a three phase type motor which has a three phase coil in the stator side, and drives the driving force source which drives the crankshaft 11 when making the engine 10 restart, and the auxiliary machinery 30, and. It functions as an AC dynamo which is driven with the engine 10 at the time of operation of the engine 10, and is generated. Based on the driving signal from the control unit 70, drive controlling of the motor 31 for an auxiliary machinery drive is carried out by the inverter 200. The inverter 200 is connected with the high voltage battery 210 and DC to DC converter 220. The high voltage battery 210 is used as a power supply for driving the motor 31 for an auxiliary machinery drive chiefly, and while the motor 31 for an auxiliary machinery drive is functioning as an AC dynamo, it stores electricity the generated electric power. It is connected with the control unit 70, and DC to DC converter 220 lowers the pressure of the voltage of the electric power generated by the voltage of the high voltage battery 210, or the motor 31 for an auxiliary machinery drive, and charges the battery 230. The battery 230 is used as a power supply for driving the motor 41 for start up and the lubricating oil pump drive motor 45 which are mentioned later, and control unit 70 grade. Although it has respectively the battery 230 for driving the high voltage battery 210 for driving the motor 31 for an auxiliary machinery drive, and the control unit 70 and the other motors 41 and 45 in this example, It has only the high voltage battery 210 and may be made to supply the electric power whose pressure was lowered via DC to DC converter 220 to the control unit 70 and the other motors 41 and 45.

[0038]Between the engine 10 and the torque converter 20, the flywheel starter gear 40 for start up are connected with the crankshaft 11, and are arranged, and the gear of the motor 41 for start up is connecting to the flywheel starter gear 40 for start up. The motor 41 for start up carries out the drive revolution of the engine 10 by using the battery 230 as a power supply at the time of the engine start except the time of the engine restart only accompanying the time of the engine start accompanied by operation of an ignition switch, i.e., idling stop processing. The gear of the motor 41 for start up is connected with the flywheel starter gear 40 only at the time of the engine start from which the ignition position sensor 58 detects the change to STA of

an ignition position from ON, and it is usually stored in the position estranged without connecting the flywheel starter gear 40 at the time. At the time of restart of the engine 10 accompanying idling stop processing, the motor 31 for an auxiliary machinery drive functions as a starter motor like previous statement. That is, in this example, at the time of the start up of the engine 10 (at the time of first time start up), start-up processing of the engine 10 is performed by the motor 41 for start up, and start-up processing of the engine 10 is performed by the motor 31 for an auxiliary machinery drive at the time of restart of the engine 10.

[0039]Start up of the engine 10 by the motor 41 for start up is start up through the flywheel starter gear 40 accompanied by a gear noise, and in repeating start up frequently, a gear noise poses a problem. Under idling stop control management, wear of the gear accompanying frequent start up also poses a problem. On the other hand, since the motor 31 for an auxiliary machinery drive is combined with the crankshaft 11 via the transmission belt 16, the time between the colds, etc. cannot drive the crankshaft 11, when the viscosity of a lubricating oil is high (rotation), and may start the engine 10. Then, at the time of restart once it puts the engine 10 into operation by the motor 41 for start up at the time of start up of the engine 10 and the engine 10 starts, the engine 10 is started by the motor 31 for an auxiliary machinery drive.

[0040]The torque converter 20 is a common fluid type torque converter, amplifies the driving torque inputted into the input shaft, and outputs it from an output shaft. Since detailed composition and operation of a torque converter are publicly known, they omit the explanation. The automatic owner stage gearbox (AT) 22 is an automatic transmission which has planetary gear inside, and changes a change gear ratio by changing the combination of a gear automatically via a hydraulic actuator (not shown) according to the vehicle speed, the amount of accelerator treading in, etc. The output shaft of AT22 is connected with the drive shaft 24, and the driving force outputted from the output shaft of AT22 is transmitted to the wheel 27 via the drive shaft 24, the differential gear 25, and the axle 26. Near AT22, the lubricating oil pump drive motor 45 for holding the oil pressure of a drive system also at the time of the shutdown of the engine 10 is arranged. The lubricating oil pump drive motor 45 is operated considering the battery 230 as a power supply.

[0041]Next, the control system of the vehicles applied to this example with reference to drawing 3 is explained. Drawing 3 is an explanatory view showing the control system of the vehicles concerning the 1st example. The control unit 70 is provided with idling stop ECU (electronic control unit) 700, engine ECU710, and brake ECU720. Each ECUs 700, 710, and 720 are equipped with CPU, ROM, RAM, etc. These ECUs are illustration, for example, can be provided with ECU which controls AT22 apart from idling stop ECU700.

[0042]Idling stop ECU700 is ECU which makes the core of the control unit 70 on the occasion of idling stop control. Idling stop ECU700 is connected with engine ECU710 and brake ECU720 via the signal wire so that two-way communication is possible. In idling stop ECU700.

The motor-rotation-frequency sensor 55 which detects the number of rotations of the fuel pressure sensor 50, the intake pressure sensor 51, the cam position sensor 52, the coolant temperature sensor 53, the crank position sensor 54, and the motor 31 for an auxiliary machinery drive, the speed sensor 56 which detects the speed of vehicles, and a gear position. The position of the shift position sensor 57 to detect and an accelerator pedal is made into an accelerator opening. The accelerator opening sensors 58 to detect, the brake pedal sensor 59 which detects the existence of treading in of a brake pedal, and the ignition position sensor 60 which detects the position of an ignition switch are connected via the signal wire, respectively. The inverter 200, the motor 41 for start up, the electromagnetic clutch 15, DC to DC converter 220, the lubricating oil pump drive motor 45, AT22, and the instrument board 46 are connected to idling stop ECU700.

[0043]Idling stop ECU700 controls the number of rotations of the motor 31 for an auxiliary machinery drive via the inverter 200, and realizes the drive of the auxiliary machinery 30 in the state where the engine 10 has stopped by idling stop processing. When making operation of the engine 10 resume from an idling stop state, instead of the motor 41 for start up, the drive revolution of the crankshaft 11 of the engine 10 is carried out, and an engine speed value is raised to starting speed. Idling stop ECU700 controls the electromagnetic actuator (not shown) of the electromagnetic clutch 15, realizes the connection and release to the flywheel 152 of the clutch plate 151, and controls transfer and interception of power. Idling stop ECU700 controls a hydraulic actuator (not shown) based on the detected information from the speed sensor 56, the shift position sensor 57, and the accelerator opening sensors 58, and changes a change gear ratio in the optimal gear change point. The program for performing start control processing concerning this example and restart control management based on the vehicles side demand is stored in ROM in idling stop ECU700.

[0044]Engine ECU710 controls the operational status of the engine 10 by controlling fuel oil consumption via the injector 12 based on the demand from idling stop ECU700, and controlling ignition timing via the igniter 14. At the time of the vehicle interdiction by idling stop processing, according to the demand from idling stop ECU700, the fuel injection through the injector 12 to the engine 10 is suspended, and operation of the engine 10 is stopped.

[0045]Brake ECU720 controls the brake actuator 47 to hold brake hydraulic pressure until it is connected with the brake actuator 47 and the driving force of the engine 10 fully rises at the time of the re-start from an idling stop state. In the case of ramp start, the state where the driving force of the engine 10 fully rises means the state where vehicles are held in a halt condition, for example, even if the brake pedal is released.

[0046]Next, general operation of vehicles provided with the above-mentioned composition is explained with reference to the lineblock diagram of drawing 1 - drawing 3. If the ignition position sensor 60 detects the change rate from ON to engine start position STA of an ignition

position in the state of the parking P or the neutral N, a shift position, After idling stop ECU700 makes the flywheel starter gear 40 connect the gear of the motor 41 for start up, it operates the motor 41 for start up, and rotates the crankshaft 11 to number of rotations at the time of engine start. Idling stop ECU700 requires start-up processing of the engine 10 from engine ECU710 in parallel. Engine ECU710 makes predetermined fuel supply in the cylinder 101 of the engine 10 via the injector 12, and it performs engine start processing which lights the fuel supplied in the cylinder 101 via the igniter 14 and the spark plug 13. In this example, it performs so that change, i.e., the control which changes fuel injection timing, may mention a fuel-injection cylinder later in start-up processing of an engine according to the fuel pressure Pf.

[0047]When operation of an engine begins, the gear of the motor 41 for start up is made to shunt by the storing position estranged from the flywheel starter gear 40. If a shift position is changed into drive D and it gets into an accelerator, vehicles will depart, Idling stop ECU700 and engine ECU710 perform operation control of the engine 10, and transmission control of AT22 based on the crank position sensor 54, the speed sensor 56, and the detected information from accelerator-opening-sensors 58 grade.

[0048]In this example, if vehicles stop temporarily by signal stop etc. during vehicle running, idling stop ECU700 will perform what is called idling stop control management that stops operation of the engine 10 under predetermined conditions. This idling stop control management is explained with reference to drawing 4. Drawing 4 is a state transition diagram showing the shift state of the control management at the time of idling stop control management.

[0049]If the ignition position sensor 47 detects the change rate of the position to ON from OFF, idling stop ECU700 will choose the mode 0 which shows the engine stopped state by processings other than idling stop processing. In this state, the indicator lamp on the instrument board 46 which indicates that idling stop processing is under execution is switched off. The ignition position sensor's 47 detection of the change to STA of an ignition position from ON will start operation of the engine 10 using the motor 14 for start up like previous statement. Idling stop ECU700 chooses the mode 1 which shows the state where the engine 10 is operating. In the state of the mode 1, vehicles are in a vehicle running condition as stated above or the vehicle interdiction state in the state where the engine 10 was operated, for example. In the state of this mode 1, and it has combined the crankshaft 11 and the transmission belt 17. [ idling stop ECU700 ] [ the electromagnetic clutch 15 ] Therefore, the auxiliary machinery 30 is driven with the driving force of the engine 10. The motor 31 for an auxiliary machinery drive is driven with the engine 10 via the transmission belt 16, it functions as an AC dynamo, and also when the high voltage battery 210 is in a full charge state, it idles. [0050]Idling stop ECU700 will choose the mode 2 which shows the processing process for stopping operation of the engine 10, if formation of idling stop control management conditions

is judged. As idling stop control management conditions, For example, the vehicle speed detected by the speed sensor 56 is 0, and it is mentioned that treading in of a brake pedal is detected by the brake pedal sensor 59, that the shift position detected by the shift position sensor 57 is the neutral N, etc. In the mode 2, idling stop ECU700 requires the stop of fuel supply from engine ECU710. Idling stop ECU700 requires maintenance of a braking state from brake ECU720. Brake ECU720 controls the brake actuator 47 and holds the brake hydraulic pressure corresponding to the amount of brake-pedal treading in.

[0051]Idling stop ECU700 will choose the mode 3 which shows the halt condition of the engine 10 by idling stop, if the shutdown of the engine 10 is judged with the detected information from the crank position sensor 54. In the mode 3, idling stop ECU700 indicates that the indicator lamp on the instrument board 46 is made to turn on, and idling stop control management is under execution. Idling stop ECU700 turns off the electromagnetic clutch 15, releases combination with the crankshaft 11 and the transmission belts 16 and 17, and makes each auxiliary machinery 30 drive by the motor 31 for an auxiliary machinery drive via the transmission belt 17.

[0052]Idling stop ECU700 will choose the mode 4 which shows the engine start control state for making operation of the engine 10 resume, if an idling stop control management terminating request is detected. When a shift position is shifted from the neutral N to drive D idling stop ECU700, for example, When less than the charging request value whose charging rate of a battery is a lower limit of a charging rate when a brake pedal is released and the cooling capabilities of an air-conditioner are insufficient, and a certain system abnormality occurs, the demand of idling stop control management is detected. In this example, when the maximum start demand for maintaining the vehicle state except the restarting requirement of the engine 10 by a driver in the predetermined state occurs, vibration control start control processing mentioned later is performed.

[0053]In the mode 4, in advance of connection of the electromagnetic clutch 15, idling stop ECU700 brakes the motor 31 for an auxiliary machinery drive, and once reduces the number of rotations of the motor 31 for an auxiliary machinery drive. Braking of the supplement motor for driving 31 is performed by inputting reversal phase current, for example. After making idling stop ECU700 connect to the connection timing determined by the electromagnetic clutch connection timing delay processing which mentions the electromagnetic clutch 15 later, The number of rotations of the motor 31 for an auxiliary machinery drive is raised to number of rotations at the time of engine start, and fuel supply and execution of jump spark ignition are required from engine ECU710. Idling stop ECU700 chooses the mode 0, when the system abnormality which cannot be run is detected.

[0054]Idling stop ECU700 will choose the mode 1, if start up of the engine 10 is judged. When the engine speed value from which idling stop ECU700 was detected by the crank position

sensor 54, for example is more than 500r.p.m., it judges with having put the engine 10 into operation. Idling stop ECU700 requires release of the brake hydraulic pressure currently held to brake ECU720. Brake ECU720 releases the brake hydraulic pressure which controls the brake actuator 47 and is held, and realizes a non braking state. If the ignition position sensor 47 detects the change to OFF from ON of a position in the state of the mode 1, idling stop ECU700 will choose the mode 0.

[0055]Then, the engine start control performed at the time of all the start up of the engine 10 concerning this example (at the time of the restart accompanying idling stop control management and the start up accompanied by ignition key operation) is explained with reference to drawing 5 thru/or drawing 10. Drawing 5 is a flow chart which shows the manipulation routine of the engine start control management performed at the time of start up of the engine 10. Drawing 6 is a flow chart which shows the manipulation routine of fuel injection control at the time of cylinder un-distinguishing [ which is performed when cylinder discrimination is not completed ]. Drawing 7 is a flow chart which shows the manipulation routine of fuel injection control at the time of the cylinder discrimination performed when cylinder discrimination is completed. Drawing 8 is a flow chart which shows the manipulation routine of fuel injection control at the time of the cylinder discrimination performed when the pipe distinction following drawing 7 is completed. Drawing 9 is a flow chart which shows the manipulation routine of fuel injection control at the time of the cylinder discrimination performed when the pipe distinction following drawing 8 is completed. Drawing 10 is a timing chart which shows the relation of a crank rotation signal, a cylinder discrimination signal, a crank position, and the distance of each cylinder 101.

[0056]Idling stop ECU700 will start this manipulation routine, if the start demand of the engine 10 occurs. It is judged whether the crank position has already become final and conclusive idling stop ECU700 (Step S100). It is because fuel injection control (it mentions later) can be performed at the time of the cylinder discrimination which performs fuel injection selectively to the cylinder 101 which greets a compression stroke, taking the fuel pressure  $P_f$  into consideration when the crank position is become final and conclusive. Therefore, when it judges with the crank position having become final and conclusive idling stop ECU700, the judgment of the fuel-pressure value in (Step S100:Yes) and this manipulation routine performs fuel-injection processing at the time of the cylinder discrimination performed and mentioned later. On the other hand, when it judges with the crank position not having become final and conclusive idling stop ECU700, (Step S100:NO) and the existence of toothless detection are judged (Step S110). That is, as shown in drawing 10, loss of teeth judges whether it is ending with detection with the crank position sensor 54. By detecting this loss of teeth, the inside of the No. 1 cylinder and the No. 6 cylinder, or [ that which cylinder 101 greets the top dead center in a compression stroke ] (namely, cylinder discrimination) -- until -- although it cannot

distinguish, it is detectable that the No. 1 cylinder or the No. 6 cylinder greets a top dead center (TDC) after 150-degreeCA. Since it cannot even perform specifying the distance of (Step S110:No) and not only a crank position but all the cylinders 101 when it judges with idling stop ECU700 not having detected loss of teeth, this processing is ended. That is, toothless detection is stood by.

[0057]On the other hand, when idling stop ECU700 judges that loss of teeth is ending with detection, it is judged whether the fuel pressure Pf detected by (Step S110:Yes) and the fuel pressure sensor 50 is less than 10 MPa (Step S120). The fuel pressure Pf shall be detected every 8 ms. If the fuel pressure Pf is 10 or more MPa, it is possible to resist cylinder (before top dead center (BTDC) 30 degrees) 101 internal pressure according to ignition timing of the beginning after cylinder decision, and to inject fuel in the cylinder 101. On the other hand, it is because it is necessary to resist cylinder 101 internal pressure, and to inject fuel in the cylinder 101, but to change fuel injection timing early if it is not before cylinder 101 internal pressure rises when the fuel pressure Pf is less than 10 MPa. Idling stop ECU700 performs fuel injection control (Step S130) at the time of (Step S120: Yes) cylinder un-distinguishing, when it judges with the fuel pressure Pf being less than 10 MPa. As mentioned above, since fuel cannot be injected in the cylinder 101 according to ignition timing of the beginning after cylinder decision even if it is standing by till the cylinder decision when the fuel pressure Pf is less than 10 MPa, when loss of teeth is detected without waiting for cylinder discrimination, fuel-injection processing is performed. The details of fuel injection control are later mentioned at the time of cylinder un-distinguishing.

[0058]On the other hand, when it judges with the fuel pressure Pf being 10 or more MPa, idling stop ECU700 waits for (Step S120:No) and cylinder discrimination, and performs fuel injection control (Step S140) at the time of cylinder discrimination. The cylinder (cylinder which finishes a compression stroke) in which loss of teeth certainly sees ignition timing first after 120-degreeCA from detection is become final and conclusive so that it can read in drawing 10. If it explains in full detail, by whether a cylinder discrimination signal (G signal) is inputted during the 120-degreeCA after toothless detection (G2 gate). It can be become final and conclusive whether which cylinder 101 sees the first ignition timing among two or more cylinders 101 which greet a compression stroke or an exhaust stroke after 150-degreeCA from toothless detection. In this example, it can become final and conclusive any shall see the first ignition timing between the No. 1 cylinder and the No. 6 cylinder.

[0059]As explained at the beginning of explanation of this manipulation routine, even if it is a case where the cylinder is not distinguished to this timing (No. 1 and BTDC150"CA of the No. 6 cylinder), If this manipulation routine is performed after cylinder decision (No. 1 and BTDC30"CA of the No. 6 cylinder), fuel injection control (Step S140) will be promptly performed at the time of cylinder discrimination.

[0060]Next, with reference to drawing 6, fuel injection control is explained at the time of cylinder un-distinguishing. It is judged whether idling stop ECU700 is what this start demand depends on an idling stop control management terminating request (Step S200). When making the engine 10 restart after idling stop, the restart of the engine 10 is required earliest possible (first-time ignition timing), but it is because it is enough if it waits for cylinder discrimination and is made to start if it is at the usual engine start time accompanied by ignition key operation. This processing is ended, in order to wait for (Step S200:No) and cylinder discrimination and to start the engine 10, when it judges with idling stop ECU700 not being in restart mode (mode 4) after idling stop. On the other hand, when idling stop ECU700 judges with it being the mode 4, it is judged whether the fuel pressure Pf detected by (Step S200:Yes) and the fuel pressure sensor 50 is 5 or more MPa (Step S210).

[0061]Idling stop ECU700 requires the fuel injection to (Step S210:Yes), the No. 1 cylinder, and the No. 6 cylinder of engine ECU710, when it judges with the fuel pressure Pf being 5 or more MPa (Step S220). That is, fuel injection (Fn1 in drawing 10) in BTDC150° of No. 1 and the No. 6 cylinder is performed. It is because the pressure in the cylinder 101 can be resisted and fuel injection can fully be performed, if No. 1 and the No. 6 cylinder in BTDC150° are in the initial stage of a compression stroke and there are 5 or more MPa of the fuel pressure Pf. As a result, the ignition in the first ignition timing S1 is realizable. Since the determination of the ignition cylinder 101 by the spark plug 13 is made after cylinder discrimination completion, jump spark ignition is performed only to the cylinder 101 which certainly finishes a compression stroke.

[0062]On the other hand, idling stop ECU700 requires the fuel injection to (Step S210:No), No. 2, and the No. 5 cylinder of engine ECU710, when it judges with the fuel pressure Pf being less than 5 MPa (Step S230). That is, fuel injection (Fn2 in drawing 10) in BTDC270° of No. 2 and the No. 5 cylinder is performed. When the fuel pressure Pf is less than 5 MPa, fuel is certainly supplied in the cylinder 101 by performing fuel injection in an intake stroke or an expansion stroke. As a result, ignition timing turns into the 2nd ignition timing S2.

[0063]The fuel injection to each cylinder 101 in this manipulation routine, When fuel injection is again performed to each cylinder [ finishing / fuel injection ] 101 in the following manipulation routines, it has a meaning as pre injection for making more reliable ignition in the first time or the 2nd ignition timing (S1, S2).

[0064]Then, fuel injection control is explained with reference to drawing 7 - drawing 10 at the time of cylinder discrimination. Idling stop ECU700 judges whether the cylinder discrimination signal (G signal) occurred in 120-degreeCA (G2 gate) from toothless detection (Step S300). Idling stop ECU700 turns off (Step S300) G signal flag Sg2, when generating of G signal is not detected in G2 gate, as shown in drawing 10 (Step S310). Since the timing chart shown in drawing 10 is a timing chart in case there is no generating of G signal into G2 gate, it explains

the case where G signal flag Sg2 is mainly OFF, by the following explanation.

[0065]Idling stop ECU700 judges whether the fuel pressure Pf is 10 or more MPa (Step S320). When it judges with the fuel pressure Pf being 10 or more MPa, the fuel injection to (Step S320:Yes) and the No. 6 cylinder is required of engine ECU710 (Step S330). That is, fuel injection (Fd1 in drawing 10) in BTDC30" of the No. 6 cylinder is performed. Thus, it is because the high fuel pressure Pf is required in order for distinguishing an injection cylinder sharply to inject fuel in the cylinder 101 to this timing and to perform ignition by the fuel pressure Pf at the first ignition timing S1. That is, it is BTDC30"CA of No. 1 and the No. 6 cylinder which a cylinder becomes final and conclusive, and cylinder 101 internal pressure which exists in the second half of a compression stroke is high. Therefore, in order to resist this cylinder 101 internal pressure and to supply fuel in the cylinder 101, the fuel pressure Pf of 10 or more MPa is needed. Thus, the engine 10 can be made to restart in the first ignition timing S1 by engine ECU710 performing fuel injection to the No. 6 cylinder.

[0066]Idling stop ECU700 judges whether (Step S320:No) and the fuel pressure Pf are 5 or more MPa, when it judges with the fuel pressure Pf being less than 10 MPa (Step S340). Idling stop ECU700 requires the fuel injection to (Step S340:Yes) and the No. 2 cylinder of engine ECU710, when it judges with the fuel pressure Pf being 5 or more MPa (Step S350). That is, fuel injection (Fd2 in drawing 10) in BTDC150" of the No. 2 cylinder is performed. Since the crank position of the No. 2 cylinder is BTDC150" (early stages of a compression stroke), if the fuel pressure Pf is 5 or more MPa, fuel can fully be supplied in the cylinder 101. However, ignition in the first ignition timing S1 cannot be performed, but serves as ignition in the 2nd ignition timing S2, and a restart of the engine 10.

[0067]Idling stop ECU700 requires the fuel injection to (Step S340:No) and the No. 4 cylinder of engine ECU710, when it judges with the fuel pressure Pf being less than 5 MPa (Step S360). That is, fuel injection (Fd3 in drawing 10) in BTDC270" of the No. 4 cylinder is performed. Since the crank position of the No. 4 cylinder is BTDC270" (intake stroke), even if the fuel pressure Pf is less than 5 MPa, fuel is fully supplied by the depression at engine manifold in the cylinder 101. However, ignition in the first ignition timing S1 cannot be performed, but serves as ignition in the 2nd ignition timing S2 in the No. 2 cylinder, or the 3rd ignition timing S3 in the No. 4 cylinder, and a restart of the engine 10.

[0068]When generating of G signal is detected in G2 gate at Step S300, (Step S300: Yes) G signal flag Sg2 is turned on (Step S370), and the cylinder 101 which performs fuel injection according to the fuel pressure Pf is determined henceforth. Since the decision processing of the fuel pressure Pf is equivalent to the case where generating of G signal is not detected in G2 gate, it explains simple by attaching a step number. When the fuel pressure Pf is 10 or more MPa, it is required for engine ECU710 that idling stop ECU700 should perform fuel injection to (Step S380:Yes) and the No. 1 cylinder (Step S390). Idling stop ECU700 is a case

(Step S380: No) where the fuel pressure Pf is less than 10 MPa, and engine ECU710 is required to perform fuel injection to (Step S400:Yes) and the No. 5 cylinder in the case of 5 or more MPa (Step S410). When the fuel pressure Pf is less than 5 MPa, it is required for engine ECU710 that idling stop ECU700 should perform fuel injection to (Step S400:No) and the No. 3 cylinder (Step S420).

[0069]Idling stop ECU700 performs 2nd fuel-injection processing, after the first fuel-injection processing is completed. First, idling stop ECU700 judges whether the fuel pressure Pf is 5 or more MPa (Step S430). Idling stop ECU700 ends (Step S430:No) and this manipulation routine, when it judges with the fuel pressure Pf being less than 5 MPa. Since the fuel injection to a compression stroke becomes impossible in the continuing fuel-injection-control processing when the fuel pressure Pf is less than 5 MPa at this time, this manipulation routine is ended. Even if it is this case, fuel is supplied to No. 4 or the No. 3 cylinder, and ignition is performed at the latest at the 3rd ignition timing S3. Fuel injection to No. 2 which sees the 2nd ignition timing S2 in front of one depending on the rise of the fuel pressure Pf, or the No. 5 cylinder, and ignition can be performed.

[0070]Idling stop ECU700 judges whether (Step S430: Yes) G signal flag Sg2 is turned on, when it judges with the fuel pressure Pf being 5 or more MPa (Step S440). Like previous statement, the timing chart of drawing 10 expresses each timing in Sg2=OFF. Idling stop ECU700 judges whether (Step S440:No) and the fuel pressure Pf are 10 or more MPa, when it judges with G signal Sg2 being turned off (Step S450). At this time, in order that the 2nd cylinder may greet TDC, it is judged whether the fuel injection in BTDC30°CA to the 2nd cylinder is possible. Idling stop ECU700 requires the fuel injection to (Step S450:Yes) and the No. 2 cylinder of engine ECU710, when it judges with the fuel pressure Pf being 10 or more MPa (Step S460). As a result, fuel injection is performed by cylinder [ 2nd ] BTDC30°CA (Fd4), and ignition is performed at the 2nd ignition timing S2. When fuel injection to the No. 2 cylinder is performed at previous Step S350, previous fuel injection functions as pre injection. In this case, the more positive ignition in the 2nd ignition timing S2 is attained.

[0071]On the other hand, idling stop ECU700 requires the fuel injection to (Step S450:No) and the No. 4 cylinder of engine ECU710, when it judges with the fuel pressure Pf being less than 10 MPa (Step S470). As a result, fuel injection is performed by cylinder [ 4th ] BTDC150°CA (Fd5), and ignition is performed at the 3rd ignition timing S3. When fuel injection to the No. 4 cylinder is performed at previous Step S360, previous fuel injection functions as pre injection. In this case, the more positive ignition in the 3rd ignition timing S3 is attained.

[0072]When it judges with G signal flag Sg2 being ON, idling stop ECU700 (Step S440:Yes), It judges whether the fuel pressure Pf is 10 or more MPa (Step S480), and when the fuel pressure Pf is 10 or more MPa, the fuel injection to (Step S480:Yes) and the No. 5 cylinder is required of engine ECU710 (Step S490). On the other hand, idling stop ECU700 requires the

fuel injection to (Step S430:No) and the No. 3 cylinder of engine ECU710, when it judges with the fuel pressure  $P_f$  being less than 10 MPa (Step S500). As a result, ignition is performed at the 3rd ignition timing. When fuel injection to the No. 3 cylinder is performed at previous Step S400, previous fuel injection functions as pre injection. In this case, the more positive ignition in the 3rd ignition timing is attained.

[0073]Thus, after the 2nd fuel injection is completed, idling stop ECU700 performs 3rd fuel injection control. First, idling stop ECU700 judges whether the fuel pressure  $P_f$  is 10 or more MPa (Step S510). Since the fuel injection to a compression stroke becomes impossible in the continuing fuel-injection-control processing when the fuel pressure  $P_f$  is less than 10 MPa at this time (Step S510: No), this manipulation routine is ended. Even if it is this case, fuel is already supplied to No. 4 or the No. 3 cylinder, and ignition is performed at the latest at the 3rd ignition timing S3.

[0074]Idling stop ECU700 judges whether (Step S510:Yes) and G signal flag are ON, when it judges with the fuel pressure  $P_f$  being 10 or more MPa (Step S520). Idling stop ECU700 requires the fuel injection to (Step S520:No) and the No. 4 cylinder of engine ECU710, when it judges with G signal flag being OFF (Step S530). On the other hand, idling stop ECU700 requires the fuel injection to (Step S520:Yes) and the No. 3 cylinder of engine ECU710, when it judges with G signal flag being ON (Step S540). As a result, fuel injection is performed by cylinder [ 4th ] BTDC30°CA, and ignition is performed at  $F_d6$  and the 3rd ignition timing S3. When fuel injection to No. 3 or the No. 4 cylinder is performed at previous Step S470 or Step S500, previous fuel injection functions as pre injection. In this case, positive ignition is attained rather than being able to set at the 3rd ignition timing S3.

[0075]As explained above, according to the start control device according to this example, when the pressure of fuel is high enough, (Ten or more MPa), It waits for cylinder discrimination, and since fuel injection can be performed to the cylinder 101 which sees ignition timing first, the engine 10 can be made to restart in the earliest stage and the ignition timing S1. That is, fuel injection in the second half of a compression stroke when only a direct injection type engine is feasible can be performed at the time of start up of the engine 10. Since fuel is injected only to the cylinder 101 by which cylinder discrimination was carried out, unburnt glow gas cannot be discharged and an exhaust gas characteristic can be raised.

[0076]Even if it is when not as high as the fuel pressure  $P_f$  permits the fuel injection in BTDC30°CA when cylinder discrimination is completed (less than 10 MPa), fuel is injected to the cylinder 101 which sees ignition timing early most according to fuel-pressure  $P_m$ . Since quick start up of the engine 10 is realizable and fuel is injected by this only to the cylinder 101 by which cylinder discrimination was carried out, unburnt glow gas cannot be discharged and an exhaust gas characteristic can be raised.

[0077]Even if it is when not as high as cylinder discrimination is not completed and the fuel

pressure  $P_f$  permits the fuel injection in BTDC30°CA, Since fuel injection in BTDC150°CA is performed to cylinder groups (specific cylinder group) which invites ignition timing to (less than 10 MPa of 5 or more MPa), and the beginning when the fuel pressure  $P_f$  is comparatively high, the 1st ignition timing S1 can be made to restart the engine 10 certainly. Since fuel injection in BTDC270°CA is performed to cylinder groups which invites ignition timing to the 2nd time in the same state when the fuel pressure  $P_f$  is comparatively low (less than 5 MPa), the 2nd ignition timing S2 can be made to restart the engine 10 certainly.

[0078]Thus, if the start control device of the engine 10 concerning this example is used, the engine 10 can be started as much as possible at an early stage, using the strong point of a direct injection type engine according to the fuel pressure  $P_f$ .

[0079]Next, engine start control management is explained with reference to drawing 11 and drawing 12 at the time of the restart performed when making the engine 10 restart by the demand by the side of vehicles. Drawing 11 is a flow chart which shows the manipulation routine performed in the state of the idling stop which has suspended engine idling operation when making the engine 10 restart by the demand from the vehicles side. Drawing 12 is a timing chart which shows intake-pipe-pressure  $P_m$  at the time of the engine restart based on the vehicles side demand, the several Nm motor revolving for an auxiliary machinery drive, and the change accompanying time progress of the engine speed value  $N_e$ .

[0080]It is judged whether idling stop ECU700 has chosen the mode 4 which shows the engine start control state for making operation of the engine 10 resume (Step S600). When it judges with idling stop ECU700 not having chosen the mode 4, (Step S600:No), This processing is ended, and when it judges with having chosen the mode 4, it is judged whether the restarting requirement of (Step S600:Yes) and the engine 10 is a thing based on the demand from the vehicles side (Step S610). Like previous statement, by inputting reversal phase current, as shown in drawing 12, the supplement motor for driving 31 is braked and the several Nm rotation falls at the time of restart of the engine 10. And the electromagnetic clutch 15 is connected in the place to which several Nm rotation of the supplement motor for driving 31 fell to the prescribed rotational frequency, and the rotor of the supplement motor for driving 31 and the crankshaft 11 of the engine 10 are combined. After the electromagnetic clutch 15 is connected, cranking (motoring) of the engine 10 is carried out with the supplement motor for driving 31. Cylinder discrimination is also performed on the occasion of cranking, and the first fuel injection is performed after cylinder discrimination. When performing this manipulation routine, abbreviated full close of the throttle valve 122 is carried out, and it has regulated the suction air quantity into the cylinder 101.

[0081]As a generation factor of the restarting requirement of the engine 10 from the vehicles side, the accelerator pedal by a driver and brake pedal operation are removed, for example, when the charging rate of a battery is less than the charging request value which is a lower

limit of a charging rate, the time of the cooling capabilities of an air-conditioner being insufficient, etc. are mentioned. When based on such a factor, the restart of the quick engine 10 is not required but it is required rather that the shock accompanying the restart of the engine 10, vibration, etc. should be controlled. Then, in this example, the throttle valve 122 has been changed into an abbreviated full-close state. When cranking by the supplement motor for driving 31 is performed until intake-pipe-pressure  $P_m$  became below in the predetermined value, and the pressure (intake-pipe-pressure  $P_m$ ) in the cylinder 101 becomes below in a predetermined pressure (negative pressure), start up of the engine 10 is started. That is, if cranking is continued the throttle valve 122 with abbreviated full close, as it is shown in drawing 12, intake-pipe-pressure  $P_m$  serves as negative pressure soon with the increase in several Nm rotation of the supplement motor for driving 31, and this means that the suction air quantity into the cylinder 101 is decreasing.

[0082]Idling stop ECU700 judges whether intake-pipe-pressure  $P_m$  detected by the intake pressure sensor 51 is below the intake-pipe-pressure decision value  $P_{mref}$  (Step S620). This intake-pipe-pressure decision value  $P_{mref}$  is set up so that the torque (firing pressure) which reduces the suction air quantity into the cylinder 101, and is generated by the explosive combustion of the beginning of the engine 10 may become small enough. When it judges with intake-pipe-pressure  $P_m$  being below the intake-pipe-pressure decision value  $P_{mref}$ , idling stop ECU700 (Step S620:Yes), the cylinder 101 determined by cylinder discrimination as shown in drawing 12 -- fuel injection -- starting (Step S630) -- ignition treatment is performed and the engine 10 is made to restart. Thus, if the pressure in the cylinder 101 is made into negative pressure and the suction air quantity into the cylinder 101 is decreased, the torque generated at the time of start up of the engine 10 becomes small, and can control a rapid torque variation. As a result, the number of rotations  $N_e$  of the engine 10 rises gently, as shown in drawing 12. Generally, it converges on atmospheric pressure with the increase in engine shutdown time, and intake-pipe-pressure  $P_m$  at the time of an engine shutdown shows behavior also with an equivalent pressure in the cylinder 101. In the conventional restart control, since the engine 10 was put into operation in this state, a lot of suction air was introduced in the cylinder 101, and big torque had occurred by explosive combustion. Such a rapid torque variation makes drivability improve, when it originates in a driver's volition, but when based on the demand by the side of vehicles, sense of incongruity will be brought about.

[0083]On the other hand, when it judges with idling stop ECU700 having intake-pipe-pressure  $P_m$  larger than the intake-pipe-pressure decision value  $P_{mref}$ , it is judged whether lapsed time  $\Delta T_s$  from (Step S620:No) and a start-up start is beyond the start-up lapsed time decision value  $T_{ref}$  (Step S640). the case where it judges with idling stop ECU700 being lapsed time  $\Delta T_s < T_{ref}$  -- (Step S640:No) -- contrast with intake-pipe-pressure  $P_m$  and the intake-pipe-pressure decision value  $P_{mref}$  is performed again (Step S620). When it judges with idling stop

ECU700 being lapsed time  $\Delta T_s \geq T_{ref}$ , (Step S640:Yes), Information of the purport that abnormalities have occurred in the suction system is performed via the instrument board 46 (Step S650), in order to prevent battery going up etc., the fuel injection to the cylinder 101 determined by cylinder discrimination is started (Step S630), and the engine 10 is made to restart via ignition treatment. Namely, priority is given to the positive restart of the engine 10 over control of the shock generated at the time of start up, and vibration.

[0084]Thus, in this example, at the time of the restart of the engine 10 based on the vehicles side start demand. Since the torque which reduces the suction air quantity into the cylinder 101, and is generated in connection with explosive combustion is controlled, it becomes possible to control the torque variation generated in connection with the restart of the engine 10, and the shock and vibration which are generated on vehicles can be reduced. Although especially start up of the engine 10 by a driver's volition gives a driver sense of incongruity, it can reduce this sense of incongruity by controlling the shock and vibration accompanying the restart of the engine 10.

[0085]As mentioned above, although the start control device of the internal-combustion engine applied to this invention based on some embodiments of the invention has been explained, the above-mentioned embodiment of the invention is for making an understanding of this invention easy, and does not limit this invention. It changes, and this invention may be improved, without deviating from the meaning and claim, and it is needless to say that the equivalent is contained in this invention.

[0086]For example, although the above-mentioned example explained the start control device of the internal-combustion engine applied to this invention based on vehicles provided with an idling stop function, if it is the vehicles which have directly an engine with which high-pressure fuel is injected in the cylinder 101, it is applicable to any vehicles. Even if it is at the start-up time accompanied by ignition key operation, the early start demand of the engine 10 exists, and if the start control device concerning this invention is used, it can meet the demand. Since fuel injection is selectively performed to the cylinder which sees ignition timing, discharge of unburnt glow gas can be controlled.

[0087]In the above-mentioned example, fuel-pressure value 10MPa is used for the judgment of whether to perform fuel injection in the second half of a compression stroke (BTDC30°CA), and fuel-pressure value 5MPa is used for the judgment of whether to perform fuel injection in early stages of a compression stroke (BTDC150°CA). However, these fuel-pressure values are illustration, in each stage, resist cylinder pressure, just inject fuel in a cylinder, and may be suitably changed based on an engine compression ratio etc.

[0088]Although the above-mentioned example explains using a six cylinder engine, it can use also to a single-cylinder engine not to mention other multiple cylinder engines, such as a 4-cylinder, 5 cylinders, 8 cylinders, and a twelve cylinder.

[0089]Although values, such as 10MPa and 5MPa, are used as a decision value of fuel pressure in the above-mentioned example, These values are suitably changed with the pressure in an engine compression stroke, for example, a higher fuel-pressure value is used with an engine with a high compression ratio, and a lower fuel-pressure value may be used with an engine with a low compression ratio. Namely, what is necessary is just a \*\*\*\* pressure of resisting the cylinder pressure power in a compression stroke, and injecting fuel.

[0090]In the above-mentioned example, although the damper is built in in the electromagnetic clutch 15, it may have the electromagnetic clutch 15 and the damper separately. On account of explanation, although the crankshaft pulley 125 and the electromagnetic clutch 15 are separately indicated to drawing 1, the electromagnetic clutch 15 may be built in the crankshaft pulley 125.

[0091]In the above-mentioned example, although the automatic owner stage gearbox was used as the transmission 22, it may replace with an automatic owner stage gearbox, and a manual type gearbox and an automatic nonstep variable speed gear may be used. In any case, idling stop control management can be performed, and the same profits as the case where an automatic owner stage gearbox is used can be obtained.

[0092]Although the above-mentioned example explained this invention based on the vehicles provided only with the engine 10 as a driving force source of vehicles, this invention can be applied also to the hybrid vehicle provided with an engine and the motor for a vehicles drive as a driving force source. Those problems are solvable by the problem same at the time of start up occurring also in this case, and applying this invention to it, when it has the direct injection type engine as an engine. After the idling stop which includes under a motor run in a hybrid vehicle, An engine may be started by the demand from the vehicles side, if restart control of the internal-combustion engine which is applied at this example in this case is performed, the vibration accompanying an engine restart will be controlled, and the displeasure given to a crew member in connection with an engine restart can be reduced.

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[Translation done.]